GROUND WATER DISCHARGE PERMIT
Kirtland Air Force Base
Underground Injection Control Wells
DRAFT DP-1839

I. INTRODUCTION

The New Mexico Environment Department (NMED) Ground Water Quality Bureau (GWQB) issues this Discharge Permit (DP-1839) for discharges via Class V underground injection control (UIC) well(s) to Kirtland Air Force Base (KAFB or Permittee) pursuant to the New Mexico Water Quality Act (WQA), New Mexico Statutes Annotated (NMSA) 1978 §§74-6-1 through 74-6-17, and the New Mexico Water Quality Control Commission (WQCC) Regulations, 20.6.2 New Mexico Administrative Code (NMAC).

The discharge that is covered by this Discharge Permit is limited to groundwater associated with the KAFB's Bulk Fuel Facility (BFF) corrective action. The groundwater is specifically the dissolved-phase portion of the contaminant plume within the regional aquifer that is elevated above the standards of 20.6.2.3103 NMAC and investigation derived waste (IDW) that meets the design parameters of the treatment system. This groundwater is being treated as an interim measure implemented pursuant to the corrective action provisions in Part 6 of KAFB's Hazardous Waste Treatment Facility Operating Permit (HWTF Permit No. NM9570024423 – "RCRA Permit").

The NMED GWQB's purpose in issuing this Discharge Permit, and in imposing the requirements and conditions specified herein, is to control the discharge of water contaminants so as to protect groundwater for present and potential future use as domestic and agricultural water supply and other uses and to protect public health. In issuing this Discharge Permit, NMED has determined that the requirements of Subsection C of 20.6.2.3109 NMAC have been or will be met. Pursuant with Section 20.6.2.3104 NMAC, it is the responsibility of the Permittee to comply with the terms and conditions of this Discharge Permit; failure to do so may result in an enforcement action(s) by NMED (20.6.2.1220 NMAC).

The NMED's Hazardous Waste Bureau (HWB) and GWQB both provide regulatory oversight at the BFF project site. The HWB regulates the evaluation and remediation of the KAFB BFF dissolved-phase plume and the associated groundwater treatment system (GWTS). The GWQB regulates the procedures that ensure treated groundwater discharged from the GWTS to UIC well(s) meet Discharge Permit requirements. This Discharge Permit is not intended to conflict or supersede the remedial actions selected for the BFF under the Resource Conservation and Recovery Act (RCRA), any implementing agreements, or the corrective action provisions of the RCRA Permit.

In the event that an associated comprehensive Work Plan or report is submitted to the NMED, NMED's HWB and GWQB will coordinate review of the comprehensive documents to ensure there is no conflict with any agency response. Associated documents will be submitted to the apparent lead bureau, copied to the other bureau, and NMED will determine which bureau will respond.

The activities which produce the discharge, the location of the discharge, and the quantity, quality, and flow characteristics of the discharge are described as follows.

The constituents of concern (CoC) within the dissolved-phase portion of the contaminant plume have been extensively investigated at the KAFB BFF under the RCRA Permit and have been narrowed to seven CoCs based on groundwater monitoring of the dissolved-phase portion of the contaminant plume within the regional aquifer. These seven CoCs have been identified as being present in untreated groundwater at concentrations potentially exceeding their respective regulatory action levels, and include ethylene dibromide (EDB), benzene, toluene, ethylbenzene, total xylenes, dissolved iron, and dissolved manganese. The CoCs and their respective effluent standards are listed in Table 2. The term "effluent standard" is used in this Discharge Permit to refer to the New Mexico Water Quality Control Commission (WQCC) groundwater standard or the federal Environmental Protection Agency (EPA) maximum contaminant level (MCL); whichever is more stringent.

Under the RCRA interim measure, contaminated groundwater is pumped from extraction wells and distributed through a piping system to a GWTS. Contaminated groundwater may also originate from groundwater monitoring or newly installed extraction wells within the dissolved-phase portion of the contaminant plume undergoing development, testing, or sampling. This liquid IDW will be transported by truck to the GWTS and added to the influent stream for treatment. This work is being completed in accordance with Work Plans approved by the NMED HWB.

The GWTS consists of a series of lead-lag granulated activated carbon (GAC) treatment vessels designed to adsorb the groundwater organic CoCs, thus reducing contaminant concentrations to at or below the effluent standards cited in Permit Condition #6 and identified in Permit Table #2. Adherence to the numeric standards will be assured by sampling the associated fluids at numerous stages of plume delineation, extraction, and treatment. Sampling associated with treatment is conducted at the influent to the GWTS, between the lead-lag GAC tanks, and at the effluent port prior to discharge to the UIC well(s). Samples collected between the lead-lag GAC tanks will notify operators when breakthrough is beginning to occur and replacement of the lead GAC tank is needed. The treatment capacity of the GWTS will be doubled in 2017 by adding a second treatment train to support the increased volume (not to exceed the permitted volume) that will be produced as additional extraction wells are installed and begin operation. Additional design changes are also planned to add additional pre-treatment and to optimize operations. This expansion/optimization of the treatment system will include two additional lead-lag GAC tanks, sand filters, and/or equipment and piping upgrades to the GWTS.

Treated effluent will be conveyed to UIC wells as defined by 20.6.2.5002.B(5)(d)(i) NMAC, including the well identified as KAFB-7 and up to four additional wells, for injection into the regional aquifer within the KAFB facility boundary. This Discharge Permit authorizes the discharge of a maximum of 1,440,000 gallons per day (gpd) via the NMED approved UIC well(s). Treated effluent is pumped from the GWTS through single-walled piping and distributed to the UIC well(s). Appendix A includes the specifics of a typical UIC well design. Final design plans will be submitted for NMED approval prior to mobilization for drilling and installation of new UIC well(s). Total discharge volume will be metered at the GWTS effluent port and at the UIC

well(s). The combined treated effluent rate of discharge employed by the Permittee will not exceed 1,000 gallons per minute (gpm), which is the maximum design treatment rate of the GWTS.

Monitoring of the extraction, treatment, and injection systems will be performed to ensure proper system operation using an automated monitoring system with a centrally located programmable logic controller (PLC) or an equivalent system. The PLC allows the operator to evaluate and control operations to maintain GWTS efficiency and effectiveness in treating the CoCs, and ensure proper discharge to the UIC well(s). Incoming data includes flowrates, pressures (*i.e.*, hydraulic head), liquid levels, groundwater levels, pump status, and alarms from the system sites. The treated effluent pumped to the UIC well(s) will be controlled via monitoring devices (*i.e.*, water level transducers and pressure head gauges) to prevent overfilling of the UIC well(s), to keep the down-hole discharge injection pipe(s) filled, and to prevent cascading of the effluent water into the UIC well(s). Effluent water will enter the UIC well casing and gravity flow through the well screen into the formation. The PLC will be programmed to alarm the operator in the event that the water level within the UIC well casing reaches the high-level set point.

The discharge, including all activities associated with the extraction and treatment of contaminated groundwater, and all associated procedures to maintain regulatory compliance with the RCRA Permit, are described in the Permittee's *Operation and Maintenance Plan* (O&M Plan). The O&M Plan is a HWB approved document that provides the procedures for management of the contaminated groundwater extraction and conveyance systems, the GWTS, and the sampling and quality assurance requirements. The O&M Plan also complies with the requirements in this Discharge Permit.

A Contingency Plan, which describes the actions that the Permittee will take in the event of a failure of the system that generates and discharges the treated effluent to a UIC well(s), is attached to this Discharge Permit at Appendix C.

KAFB is located southeast of Albuquerque in Bernalillo County. The discharge authorized by this Discharge Permit is located within the Designated UIC Area in Section 01 of T9N R3E, Sections 05, 06, 07, 08, and 09 of T9N R4E, and Section 31 of T10N R4E in the southern portion of the facility proximal to the groundwater monitoring wells associated with the existing nitrate plume (SWMU ST-105). Permit Appendix B identifies the Designated UIC Area and the current footprint of the 10 milligrams per liter (mg/L) nitrate plume within the regional aquifer. Additional UIC wells and associated infrastructure installed within the Designated UIC Area are subject to the conditions of this Discharge Permit and would not require a permit modification in accordance with 20.6.2.7(P) NMAC.

The nitrate plume is being remediated under the *Site ST-105 Stage 2 Abatement Plan for Nitrate Contaminated Water* (Abatement Plan) dated October 2007, which was approved by the GWQB Remediation Oversight Section in correspondence dated September 26, 2008. The most current version of the approved Abatement Plan may be viewed at the GWQB's web site at https://www.env.nm.gov/gwb/RemediationOversight.htm.

The regional groundwater beneath the SWMU ST-105 where KAFB-7 and the proposed UIC well(s) are located ranges from a depth of 202 to 709 feet (ft) below ground surface (bgs) with an average of 434 ft bgs and has a total dissolved solids (TDS) concentration ranging from 160 to 1200 mg/L with an average of 345 mg/L.

The application consists of the *Discharge Permit Application* (Application) submitted by the Permittee on December 4, 2015, a revised Application submitted by the Permittee on September 28, 2016, and additional information submitted as requested by NMED. The discharge shall be managed in accordance with all conditions and requirements of this Discharge Permit.

Pursuant to Section 20.6.2.3109 NMAC, NMED reserves the right to require a discharge permit modification in the event NMED determines that the requirements of 20.6.2 NMAC are being or may be violated or the standards of Section 20.6.2.3103 NMAC are being or may be violated. This may include a determination that structural controls and/or management practices approved under this Discharge Permit are not protective of groundwater quality and that more stringent requirements to protect groundwater quality may be required by NMED. Though conformance with this Discharge Permit and the RCRA Permit would result in a very low probability of there being a discharge causing groundwater contamination above applicable standards, NMED reserves the right to require remediation of such a discharge.

Issuance of this Discharge Permit does not relieve the Permittee of the responsibility to comply with the WQA, WQCC Regulations, and any other applicable federal, state, and/or local laws, regulations, zoning requirements, and nuisance ordinances.

The following acronyms and abbreviations may be used in this Discharge Permit:

Abbreviation	Explanation		Abbreviation	Explanation
bgs	below ground surface		MCL	maximum contaminant level
BFF	Bulk Fuels Facility		mg/L	milligrams per liter
CFR	Code of Federal Regulations		mL	milliliters
CoCs	constituents of concern		NMAC	New Mexico Administrative Code
DP	Discharge Permit		NMED	New Mexico Environment Department
EDB	ethylene dibromide		NMSA	New Mexico Statutes Annotated
EPA	United States Environmental Protection Agency		NO_3-N	nitrate-nitrogen
GAC	granulated activated carbon		O&M Plan	Operation and Maintenance Plan
gpd	gallons per day		PLC	programmable logic controller
gpm	gallons per minute		RCRA	Resource Conservation and Recovery Act
GWTS	groundwater treatment system		SWMU	solid waste management unit
GWQB	Ground Water Quality Bureau		TDS	total dissolved solids
ft	feet		total nitrogen	= TKN + NO_3-N
HWB	Hazardous Waste Bureau		UIC	underground injection control
HWTF	Hazardous Waste Treatment Facility		VOC	volatile organic carbon
IDW	investigation derived waste		WQA	New Mexico Water Quality Act
KAFB	Kirtland Air Force Base		WQCC	Water Quality Control Commission

II. FINDINGS

In issuing this Discharge Permit, NMED finds the following:

1. The Permittee is discharging effluent treated to at or below regulatory standards from the facility so that such effluent may move directly or indirectly into groundwater within the meaning of Section 20.6.2.3104 NMAC.

2. The Permittee is discharging effluent from the facility so that such effluent may move into groundwater of the State of New Mexico which has an existing concentration of 10,000 mg/L or less of TDS within the meaning of 20.6.2.3101(A) NMAC.

3. The discharge from the facility is not subject to any of the exemptions of Section 20.6.2.3105 NMAC.

4. The Permittee is operating UIC recharge well(s) within the meaning of 20.6.2.5002(A)(1) and 20.6.2.5002(B)(5)(d)(i) NMAC which is subject to the prohibitions listed under 20.6.2.5004(A)(4) NMAC.

III. AUTHORIZATION TO DISCHARGE

Pursuant to 20.6.2.3104 NMAC, it is the responsibility of the Permittee to ensure that discharges authorized by this Discharge Permit are consistent with the terms and conditions herein.

The Permittee is authorized to discharge up to 1,440,000 gpd of treated effluent via a maximum of five UIC wells to the groundwater aquifer within the Designated UIC Area in Section 01 of T9N R3E (KAFB-7), Sections 05, 06, 07, 08, and 09 of T9N R4E, and Section 31 of T10N R4E, Bernalillo County, NM. The Designated UIC Area is identified in Appendix B. UIC wells currently authorized by this Discharge Permit are identified in Table 1. Up to four additional UIC wells may be proposed pursuant to Permit Condition #11 of this Discharge Permit.

[20.6.2.3104 NMAC, 20.6.2.3106(C) NMAC, 20.6.2.3109(C) NMAC]

IV. CONDITIONS

The following conditions shall be complied with by the Permittee and are enforceable by NMED. Any reference in this Discharge Permit to communication with NMED shall be inferred to mean communication with the Bureau Chiefs of the GWQB and the HWB. The Permittee is authorized to discharge treated effluent subject to the following conditions.

A. OPERATIONAL PLAN

#	**Terms and Conditions**
1.	The Permittee shall implement the following operational plan to ensure compliance with Title 20, Chapter 6, Parts 2 and 4 NMAC. [20.6.2.3109.C NMAC]
2.	The Permittee shall operate in a manner such that standards and requirements of Sections 20.6.2.3101 and 20.6.2.3103 NMAC are not violated. [20.6.2.3101 NMAC, 20.6.2.3103 NMAC, 20.6.2.3109(C) NMAC]
3.	The Permittee shall ensure that the most recent versions of all Work Plans associated with the GWTS, the effluent conveyance pipeline, and the UIC well(s) are consistent with the requirements of this Discharge Permit. [20.6.2.3101 NMAC, 20.6.2.3103 NMAC, 20.6.2.3109(C) NMAC]
4.	The Permittee shall ensure all discharges associated with this Discharge Permit are located within the Designated UIC Area within Section 01 of T9N R3E, Sections 05, 06, 07, 08, and 09 of T9N R4E, and Section 31 of T10N R4E (See Appendix B). [20.6.2.3101 NMAC, 20.6.2.3103 NMAC, 20.6.2.3109(C) NMAC]
5.	The Permittee shall ensure that proposed UIC well locations (see Appendix B) and associated discharges are consistent with the most recent approved Stage 2 Abatement Plan for SWMU ST-105. [20.6.2.3101 NMAC, 20.6.2.3103 NMAC, 20.6.2.3109(C) NMAC]
6.	The Permittee shall ensure that discharged groundwater effluent is less than or equal to the effluent standards for all constituents referenced in 20.6.2.3103 NMAC. The term “effluent standard” is used in this Discharge Permit to refer to the New Mexico Water Quality Control Commission (WQCC) groundwater standard or the federal Environmental Protection Agency (EPA) maximum contaminant level (MCL); whichever is more stringent.

#	**Terms and Conditions**
	[20.6.2.3109(C) NMAC, 20.7.10.100 NMAC]
7.	The Permittee shall ensure that GWTS influent chemistry is consistent with the design basis of the GWTS. [20.6.2.3109(C) NMAC, 20.7.10.100 NMAC]
8.	The Permittee is authorized to install and operate not more than five UIC wells. Authorized UIC wells are listed in Table 1. [20.6.2.3109(C) NMAC, 20.7.10.100 NMAC]
9.	The Permittee shall ensure that the total discharge from the facility via UIC wells does not exceed 1,440,000 gpd. [20.6.2.3109(C) NMAC, 20.7.10.100 NMAC]
10.	Prior to the installation of a new UIC well, the Permittee shall submit a Work Plan for NMED approval that satisfies the requirements of this Discharge Permit and the corrective action provisions at Part 6 of the RCRA Permit. This Work Plan shall, at a minimum, include the following information unless the Permittee can demonstrate to NMED that an item is not applicable or appropriate under the proposed activity or if an item has been provided separately under another submission: a. A statement of purpose and need for the additional UIC well(s); b. A list of groundwater monitoring wells which may be added to the monitoring program to effectively monitor performance of the new UIC well(s); c. A map showing the location of the proposed UIC well(s) and the location of all associated monitoring well(s); d. The geographic coordinates of the location of the UIC well(s) including township/range and section; e. A map showing the location of the nearest production well; f. A proposal of how the structural integrity of the treated effluent conveyance system between the GWTS and the new well will be demonstrated; g. Existing data showing the depth to water and general groundwater quality at the proposed new UIC well discharge location; h. A detailed description of groundwater flow modeling (numeric or analytical) predicting the effect of injection on the groundwater flow direction at the discharge location; i. A detailed description of geochemical modeling (numeric or analytical) evaluating the interaction between the treated effluent and receiving groundwater. Prior to any such geochemical modeling the treated effluent and receiving groundwater shall be

#	**Terms and Conditions**
	tested for the analytes listed in Table 5 unless the Permittee can demonstrate that testing for a particular analyte is unnecessary; j. A detailed description of the impact that the proposed injection will have on any known groundwater contaminant plumes, e.g., the nitrate plume(s) addressed in the Site ST-105 Stage 2 Abatement Plan for Nitrate Contaminated Water; k. Maximum estimated monthly discharge volume to the UIC well(s); l. Project schedule, including the date the discharge is to commence and the anticipated duration; and m. Necessary changes to this Discharge Permit's language should the proposal be approved, *e.g.*, the listing of authorized injection wells and associated monitoring wells in Table 1. These Work Plans shall be submitted for NMED approval at least 90 days prior to the scheduled installation of any UIC well. Proposed changes to this Discharge Permit constituting a "permit modification" as defined at 20.6.2.7.P NMAC shall not be submitted as a Work Plan, but shall instead be submitted as a discharge permit modification request as specified at 20.6.2.3109.G NMAC. A proposal to locate a discharge at a location outside the areas specified in Permit Condition #4 shall be considered a permit modification. A proposal to locate a UIC well at a location within the Designated UIC Area shall not be considered a permit modification unless the discharge quality or quantity is modified from that permitted herein. The Permittee shall post the approved Work Plan to the appropriate web site, *i.e.*, KAFB/Environment/Kirtland AFB Fuel Plume Project Documents. [20.6.2.7(P) NMAC, 20.6.2.3107(A) NMAC, 20.6.2.3109(G) NMAC, 20.6.2.5003 NMAC]
11.	Prior to discharging to a newly installed UIC well, the Permittee shall submit written notification to NMED stating the date that the discharge is to commence. [20.6.2.3107(A) NMAC]
12.	The Permittee shall ensure that the GWTS is secured to control access by the general public. [20.6.2.3109(B) and(C) NMAC, NMSA 1978, §74-6-5(D)]
13.	The Permittee shall maintain signs in English and Spanish (unless otherwise prohibited by KAFB policy) at appropriate locations indicating that the GWTS effluent is non-potable. Signs shall be posted at the UIC wellheads, at the GWTS, and any associated UIC well-related infrastructure.

#	**Terms and Conditions**
	[20.6.2.3109(B) and(C) NMAC, NMSA 1978, § 74-6-5(D)]
14.	The Permittee shall ensure that the UIC well(s) include monitoring devices, *i.e.*, water level and pressure head transducers, to prevent overfilling of the well. The Permittee shall measure the volume of treated effluent discharged to each UIC well and maintain a record of these volumes. [20.6.2.3107 and 20.6.2.3109(C)(3)(c)(i) NMAC]
15.	The Permittee shall ensure the treated effluent conveyance system, *i.e.*, piping, between the GWTS and the UIC well(s) does not leak and shall report any such leakage to the NMED GWQB in accordance with 20.6.2.1203(A) NMAC and copy the NMED HWB. Within one year of the effective date of this Discharge Permit, the Permittee shall demonstrate the structural integrity of the treated effluent conveyance system between the GWTS and KAFB-7. Prior to testing, the Permittee shall propose for NMED approval the test method to be used. The results of the mechanical integrity testing shall be submitted to NMED within 60 days of test completion. The Permittee shall integrity test the treated effluent conveyance system between GWTS and the UIC well(s) prior to submitting a permit renewal application. [20.6.2.3106(C) NMAC, 20.6.2.3107(A) NMAC]
16.	Prior to an initial discharge from the GWTS of treated effluent associated with a new extraction well, the Permittee shall submit documentation to NMED demonstrating that the treated effluent is at or below the effluent standards specified for the CoCs listed in Table 2. [20.6.2.1202(A) and (C) NMAC, 20.6.2.3109(C) NMAC, NMSA 1978, §§ 61-23-1 through 61-23-32]

B. MONITORING, REPORTING, AND OTHER REQUIREMENTS

#	**Terms and Conditions**
17.	The Permittee shall conduct the monitoring, operations, and reporting listed below. Unless otherwise specified, all periodic monitoring results or general information obtained shall be reported in the forthcoming quarterly report. [20.6.2.3107 NMAC]

#	**Terms and Conditions**
18.	Unless otherwise approved by NMED, the Permittee shall conduct sampling in accordance with standard industry practice. Sampling in accordance with the most current version of the GWTS Sampling and Analysis Plan (Appendix L of the O&M Plan), which includes sampling locations, procedures, field measurements, quality control samples, handling and custody, analytical methods, quality control, analytical validation, and reporting requirements, satisfies this Condition. [20.6.2.3107(B) NMAC]
19.	The Permittee shall submit quarterly and annual reports to NMED pursuant to the most recent NMED HWB approved Work Plans. The Permittee shall identify the portions of these reports pertaining to this Discharge Permit with a table in the reports that identifies those portions. Quarterly reports shall be submitted as specified below unless otherwise authorized by NMED: • January 1st through March 31st – due by June 30th • April 1st through June 30th – due by September 30th • July 1st through September 30th – due by December 31st • October 1st through December 31st – due by March 31st Annual reporting requirements for the previous year, i.e., January 1st through March 31st, shall be reported in the March 31st quarterly report. [20.6.2.3107(A) NMAC]
20.	The Permittee shall monitor the concentration of all CoCs listed on Table 2 in GWTS treated effluent. Associated sampling and analysis shall be performed monthly at a minimum. When groundwater from a new extraction well is first introduced to the GWTS, CoC monitoring of the GWTS treated effluent shall occur daily for the first week of treatment, weekly for the first month of treatment, and monthly thereafter. If alterations to, or conditions at, the GWTS result in a potential impact to effluent quality, the Permittee will repeat this sampling sequence as directed by NMED. A representative sample of GWTS influent and effluent shall be analyzed annually for the constituents identified in Table 3. A representative sample of GWTS influent and effluent shall be analyzed every five years for the constituents identified in Table 4. The first analysis of the five-year constituent list shall occur in July 2017. Any newly identified constituents detected during the five-years sampling events will be added to the annual sampling constituent list in Table 3.

#	**Terms and Conditions**
	All analysis of GWTS influent and effluent shall utilize analytical methods with detection limits that are sufficiently low to allow comparison to the standards included in the above referenced state and federal regulations. All sampling, analysis, and reporting shall comply with the most recent approved Work Plans. [20.6.2.3107(A) NMAC and 20.6.2.3107(B) NMAC]
21.	The Permittee shall report the volume of treated GWTS effluent discharged to each UIC well each quarter. This report shall include the following: a. Monthly average, maximum, and minimum values for flow rate and volume of treated effluent transferred to each UIC well; b. The totalized monthly volume of treated effluent transferred to all UIC wells; and c. Monthly average, maximum, and minimum head values of injection water for each UIC well. The Permittee shall monitor the GWTS effluent volume utilizing an effluent flow meter installed on the effluent pump skid after the GAC units. Each UIC well shall have a dedicated flow meter. Flow meters shall be inspected and calibrated in accordance with the associated manufacturer's recommendations. [20.6.2.3107 NMAC]
22.	The Permittee shall include the following results and general information in quarterly reports to NMED: a. Any mechanical integrity conducted on either the GWTS or a UIC well; b. Any replacement of GAC media and the associated data that initiated the decision to replace the media; c. Any UIC well rehabilitation conducted; d. Any malfunction, repair, or replacement of a flow meter; and e. Any additional operational changes with the potential to affect the discharge. [20.6.2.3107 NMAC]
23.	The Permittee shall monitor the groundwater wells in the vicinity of KAFB-7 and in the vicinity of any newly installed UIC well(s) to determine any change to aquifer chemistry that may be the result of injection. This monitoring shall be performed annually, shall conform to the procedures of the most current approved Work Plan, and shall measure the CoCs listed in Table 2. This chemistry will be reported in the Annual Report for BFF. ST-105 Annual Report includes elevation contour mapping and analytical parameters identified in the Stage 2 Abatement Plan.

#	**Terms and Conditions**
	The Permittee shall develop a groundwater elevation contour map depicting the groundwater flow direction in the vicinity of each UIC well and report it in the ST-105 Annual Report. If the chemical quality of the treated groundwater being injected changes over time, NMED may require the Permittee to repeat geochemical modeling (numeric or analytical) to predict the interaction between the treated effluent and receiving groundwater. [20.6.2.3107 NMAC]
24.	The Permittee shall post all reports required by this Discharge Permit on KAFB's most current web site (e.g., https://kirtlandafb.tlisolutions.com/main.aspx.) [20.6.2.3107(A) NMAC]

C. CONTINGENCY PLAN

#	**Terms and Conditions**
25.	If the automated monitoring system records a system alarm indicating a threat condition to a UIC well, and that threat condition is confirmed, at a minimum the affected UIC well will be taken off-line. If the alarm condition is confirmed during the response investigation, the UIC well(s) will be taken off-line and the discharge to the UIC well(s) will not be resumed until the problem is identified and corrected. [20.6.2.3107(A) NMAC]
26.	In accordance with this Discharge Permit, if the discharge to a UIC well exceeds effluent standards, the Permittee shall enact the Contingency Plan (Appendix C). The Permittee may be required to remediate water pollution in accordance with the corrective action provisions in Part 6 of the RCRA Permit except as provided in 20.6.2.4105(B) NMAC. [20.6.2.3107(A) NMAC, 20.6.2.3109(E) NMAC, 20.6.2.4105(A)(2) and (3) NMAC]
27.	In the event that a release or a spill occurs that is not authorized under this Discharge Permit, the Permittee shall notify the NMED GWQB in accordance with 20.6.2.1203(A) NMAC, shall include any additional reporting requirements specified at RCRA Permit Section 1.27, and shall copy the NMED HWB. The Permittee shall also take measures to mitigate damage from the unauthorized discharge and initiate corrective actions specified in the Contingency Plan (Appendix C). The Permittee may be required to remediate water pollution in accordance with the corrective action provisions in Part 6 of the RCRA Permit except as provided in 20.6.2.4105(B) NMAC.

#	Terms and Conditions
	Nothing in this condition shall be construed as relieving the Permittee of the obligation to comply with all requirements of Section 20.6.2.1203 NMAC. [20.6.2.1203 NMAC, 20.6.2.4105(A)(2) and (3) NMAC]
28.	In the event that information indicates that a UIC well referenced at Table 1 is not constructed in a manner consistent with its intended use or is not completed in a manner that is protective of groundwater quality, the Permittee shall submit a Work Plan to the NMED with a proposal for well rehabilitation, abandonment only, or abandonment and replacement. This Work Plan shall include a project schedule and shall be submitted for NMED approval within 120 days following confirmation of the above referenced problems. The Permittee may propose an alternate use for the well. The UIC well requiring replacement shall be properly plugged and abandoned in accordance with Part 6.5.17.10.9 of the RCRA permit. [20.6.2.3107(A) NMAC, 20.6.2.5005 NMAC]
29.	In the event that NMED or the Permittee identifies any failures of the Application or this Discharge Permit not specifically noted herein, NMED may require the Permittee to submit a corrective action plan and a schedule for completion of corrective actions to address the failures. Additionally, NMED may require a modification to this Discharge Permit to achieve compliance with 20.6.2 NMAC. [20.6.2.3107(A) NMAC, 20.6.2.3109(E) NMAC]

D. CLOSURE PLAN

#	Terms and Conditions
30.	Upon permanent cessation of discharge to a UIC well(s), the Permittee shall perform the following closure measures upon NMED approval, unless UIC well(s) and/or conveyance pipelines are needed for another use: a) Cap, plug, or remove all conveyance pipelines to prevent the discharge of GWTS treated effluent to all UIC well(s); b) Abandon UIC well(s) in accordance with Part 6.5.17.10.9 of the RCRA permit, which reference OSE regulation 19.27.4.30 and 31 NMAC and associated well abandonment guidance; and c) Appropriately dispose of any wastes associated with UIC well plugging and abandonment. The Permittee may, instead of abandoning a UIC well, propose an alternate use for the well.

	Upon cessation of the closure measures, the Permittee shall perform the following post-closure measures: a) Continue monitoring CoCs in groundwater for at least two years, or as appropriate and in concurrence with NMED; and b) Enact the release notification requirements of the Contingency Plan if groundwater standards are exceeded. The Permittee may be required to remediate water pollution in accordance with the corrective action provisions in Part 6 of the RCRA Permit except as provided in 20.6.2.4105(B) NMAC. When all post-closure requirements have been met, the Permittee may request to terminate the Discharge Permit. [20.6.2.3107 (A)11 NMAC]

E. GENERAL TERMS AND CONDITIONS

#	Terms and Conditions
31.	The Permittee shall maintain a written record of the following information: a) Information and data used to complete the Application for this Discharge Permit; b) Records of any releases or spills not authorized under this Discharge Permit and reports submitted pursuant to 20.6.2.1203 NMAC; c) Records of the operation, maintenance, and repair of all facilities/equipment used to treat, store, or inject the treated groundwater; d) Facility record drawings (plans and specifications) showing the actual construction of the facility and that the construction complies with all applicable statutes, regulations, and codes including applicable Department of Defense Engineering Standards; e) Copies of quarterly reports completed and/or submitted to NMED pursuant to this Discharge Permit; f) The volume of treated water discharged pursuant to this Discharge Permit; g) Groundwater quality and injected water quality data collected pursuant to this Discharge Permit; h) Copies of construction records and well logs for all groundwater monitoring wells required to be sampled pursuant to this Discharge Permit; i) Records of the maintenance, repair, replacement, or calibration of any monitoring equipment or flow measurement devices required by this Discharge Permit; and j) Data and information related to field measurements, sampling, and analysis conducted pursuant to this Discharge Permit. The following information shall be recorded and made available to NMED upon request: i) The dates, location, and times of sampling or field measurements; ii) The sample analysis date of each sample; iii) The name and address of the laboratory, and the name of the signatory authority for the laboratory analysis;

#	**Terms and Conditions**
	iv) The analytical technique or method used to analyze each sample or collect each field measurement; v) The results of each analysis or field measurement; vi) The results of any split, spiked, duplicate or repeat sample; and vii) A copy of the laboratory analysis chain-of-custody as well as a description of the quality assurance and quality control procedures used. The written record shall be maintained by the Permittee so that it is accessible within a reasonable time period during or following a facility inspection by NMED through the post-closure period and shall be made available to NMED upon request. [20.6.2.3107(A) and (C) NMAC]
32.	The Permittee shall allow NMED representatives to inspect the facility and its operations which are subject to this Discharge Permit and the WQCC regulations. NMED representatives may, upon presentation of proper credentials, enter at reasonable times upon or through any premises in which a water contaminant source is located or in which any records are located regarding this discharge permit or related discharges required to be maintained by regulations of the federal government or the WQCC. The Permittee shall allow NMED representatives to have access to any copy of the records, and to perform assessments, sampling, or monitoring during an inspection for the purpose of evaluating compliance with this Discharge Permit and the WQCC regulations. Nothing in this Discharge Permit shall be construed as limiting in any way the inspection and entry authority of NMED under the WQA, the WQCC Regulations, or any other local, state, or federal regulations. [20.6.2.3107(D) NMAC, NMSA 1978, §§ 74-6-9(B) and 74-6-9(E)]
33.	The Permittee shall, upon NMED's request, allow for NMED's duplication of records required by this Discharge Permit and/or furnish to NMED electronic copies of such records. [20.6.2.3107(D) NMAC]
34.	In the event the Permittee proposes a change to the facility or the facility's discharge that would result in a change in the volume discharged; the location of the discharge; or in the amount or character of water contaminants received, treated, or discharged by the facility that differs from the terms and conditions in this Discharge Permit, the Permittee shall notify NMED prior to implementing such changes. The Permittee shall obtain approval (which may require modification of this Discharge Permit) by NMED prior to implementing such changes.

#	**Terms and Conditions**
	[20.6.2.7(P) NMAC, 20.6.2.3107(C) NMAC, 20.6.2.3109(E) and (G) NMAC]
35.	In the event the Permittee proposes to construct or change an existing system such that the quantity or quality of the discharge will change substantially from that authorized by this Discharge Permit, the Permittee shall submit construction plans and specifications to NMED for the proposed system or process unit prior to the commencement of construction. In the event the Permittee implements changes to an existing system authorized by this Discharge Permit which will result in only a minor effect on the quality of the discharge, the Permittee shall report such changes (including the submission of record drawings, where applicable) in the next quarterly report to NMED. [20.6.2.1202(A) and (C) NMAC, NMSA 1978, §§ 61-23-1 through 61-23-32]
36.	Any violation of the requirements and conditions of this Discharge Permit, including any failure to allow properly credentialed NMED staff to enter and inspect records or facilities, or any refusal or failure to provide NMED with records or information required to be maintained by this Discharge Permit or related regulation may subject the Permittee to a civil enforcement action. Pursuant to WQA 74-6-10(A) and (B), such action may include a compliance order requiring compliance immediately or in a specified time, assessing a civil penalty, modifying or terminating the Discharge Permit, or any combination of the foregoing; or an action in district court seeking injunctive relief, civil penalties, or both. Pursuant to WQA 74-6-10(C) and 74-6-10.1, civil penalties of up to $15,000 per day of noncompliance may be assessed for each violation of the WQA 74-6-5, the WQCC Regulations, or this Discharge Permit, and civil penalties of up to $10,000 per day of noncompliance may be assessed for each violation of any other provision of the WQA, or any regulation, standard, or order adopted pursuant to such other provision. In any action to enforce this Discharge Permit, the Permittee waives any objection to the admissibility as evidence of any data generated pursuant to this Discharge Permit. [20.6.2.1220 NMAC, NMSA 1978, §§ 74-6-10 and 74-6-10.1]
37.	No person shall: 1) make any false material statement, representation, certification, or omission of material fact in an application, record, report, plan, or other document filed, submitted, or required to be maintained under the WQA; 2) falsify, tamper with, or render inaccurate any monitoring device, method, or record required to be maintained under the WQA; or 3) fail to monitor, sample, or report as required by a permit issued pursuant to a state or federal law or regulation.

#	**Terms and Conditions**
	Any person who knowingly violates or knowingly causes or allows another person to violate the requirements of this condition is guilty of a fourth degree felony and shall be sentenced in accordance with the provisions of NMSA 1978, § 31-18-15. Any person who is convicted of a second or subsequent violation of the requirements of this condition is guilty of a third degree felony and shall be sentenced in accordance with the provisions of NMSA 1978, § 31-18-15. Any person who knowingly violates the requirements of this condition or knowingly causes another person to violate the requirements of this condition and thereby causes a substantial adverse environmental impact is guilty of a third degree felony and shall be sentenced in accordance with the provisions of NMSA 1978, § 31-18-15. Any person who knowingly violates the requirements of this condition and knows at the time of the violation that he is creating a substantial danger of death or serious bodily injury to any other person is guilty of a second degree felony and shall be sentenced in accordance with the provisions of NMSA 1978, § 31-18-15. [20.6.2.1220 NMAC, NMSA 1978, §§ 74-6-10.2(A) through 74-6-10.2.F]
38.	Nothing in this Discharge Permit shall be construed in any way as relieving the Permittee of the obligation to comply with all applicable federal, state, and local laws, regulations, permits, or orders. [NMSA 1978, § 74-6-5.L]
39.	The Permittee may file a petition for review before the WQCC on this Discharge Permit. Such petition shall be in writing to the WQCC within thirty days of the receipt of postal notice of this Discharge Permit and shall include a statement of the issues to be raised and the relief sought. Unless a timely petition for review is made, the decision of NMED shall be final and not subject to judicial review. [20.6.2.3112 NMAC, NMSA 1978, § 74-6-5.O]
40.	Prior to the transfer of any ownership, control, or possession of this facility or any portion thereof, the Permittee shall: 1) notify the proposed transferee in writing of the existence of this Discharge Permit; 2) include a copy of this Discharge Permit with the notice; and 3) Deliver or send by certified mail to NMED a copy of the notification and proof that such notification has been received by the proposed transferee. Until both ownership and possession of the facility have been transferred to the transferee, the Permittee shall continue to be responsible for any discharge from the facility. [20.6.2.3111 NMAC]

#	**Terms and Conditions**
41.	Payment of permit fees is due at the time of Discharge Permit approval. Permit fees shall be paid in a single payment or shall be paid in equal installments on a yearly basis over the term of the Discharge Permit. Single payments shall be remitted to NMED no later than 30 days after the Discharge Permit effective date. Initial installment payments shall be remitted to NMED no later than 30 days after the Discharge Permit effective date; subsequent installment payments shall be remitted to NMED no later than the anniversary of the Discharge Permit effective date. Permit fees are associated with issuance of this Discharge Permit. Nothing in this Discharge Permit shall be construed as relieving the Permittee of the obligation to pay all permit fees assessed by NMED. A Permittee that ceases discharging or does not commence discharging from the facility during the term of the Discharge Permit shall pay all permit fees assessed by NMED. An approved discharge permit shall be suspended or terminated if the facility fails to remit an installment payment by its due date. [20.6.2.3114(F) NMAC, NMSA 1978, § 74-6-5(K)]

TABLE 1 - Authorized Underground Injection Control Wells

Well Identifier	Well Location	Associated Monitoring Wells
KAFB-7	Latitude 35º 02’ 31.41” N Longitude 106º 34’ 10.79” W Section 01 of T9N R3E	KAFB-0505, KAFB-0507, KAFB-0508

TABLE 2 - Constituents of Concern (CoCs)

(Constituents measured in the dissolved-phase portion of BFF plume at concentrations exceeding effluent standards.)

Constituent	Effluent Standards
Ethylene dibromide (EDB)	0.05 µg/L
Benzene	5.0 µg/L
Ethylbenzene	700 µg/L
Toluene	750 µg/L
Total xylenes	620 µg/L
Iron	1,000 µg/L
Manganese	200 µg/L

TABLE 3 - Annual Monitoring Constituent List

(Constituents having 20.6.2.3103 NMAC Human Health Standards and Federal Drinking Water Primary Maximum Contaminant Levels (MCLs) that have ever been detected within KAFB BFF site wells. Permittee may petition NMED to change a constituent monitoring frequency from annual to once every five years, i.e., move to Table 4, if after eight consecutive quarters of monitoring the constituent is not detected in any BFF site wells.)

Category	Constituent
Anions	
	chloride
	nitrogen (nitrate-nitrite)
	sulfate
Organic compounds	
	1,1,2,2-tetrachloroethane
	1,1,2,2-tetrachloroethylene (PCE)
	1,1,2-trichloroethane
	1,1,2-trichloroethylene (TCE)
	1,2-dichloroethane (EDC)
	1,1-dichloroethane
	1,2-dibromomethane
	bis(2-ethylhexyl) phthalate
	Chloroform
	cis-1,2-dichloroethylene
	Dibromochloromethane
	Methylene chloride
	Naphthalenes
	Phenols
	Pyrene

TABLE 4 – Five-year Monitoring Constituent List

(Constituents with 20.6.2.3103 NMAC action levels and Federal Drinking Water maximum contaminant levels (MCLs) – this list is not meant to be redundant with Table 3)

Category	Constituent
Anion	
	Fluoride
Metals	
	Aluminum
	Antimony
	Arsenic
	Barium
	Beryllium
	Cadmium
	Chromium
	Copper
	Cyanide (as free Cyanide)
	Lead
	Manganese
	Mercury (total)
	Selenium
	Silver
	Thallium
	Uranium
	Zinc
Organic compounds	
	Dichloromethane
	Methyl tertiary butyl ether (MTBE)

TABLE 5 – Geochemical Modeling Analyte List

Analyte
Calcium
Magnesium
Sodium
Potassium
Chloride
Sulfate
Total Carbonate Alkalinity
Silica
Iron
Manganese
Dissolved Organic Carbon
Aluminum
Arsenic
Barium
Nitrate-Nitrite(N)
Strontium
Temperature (°C)
pH
ORP (mV), Eh (mV)
DO
Charge Balance (%)

PERMIT TERM & SIGNATURE

EFFECTIVE DATE: [effective date]
EXPIRATION DATE: [Seven years from the effective date or five years from the date the discharge commences, whichever comes first]

[Subsection H of 20.6.2.3109 NMAC, NMSA 1978, § 74-6-5.I]

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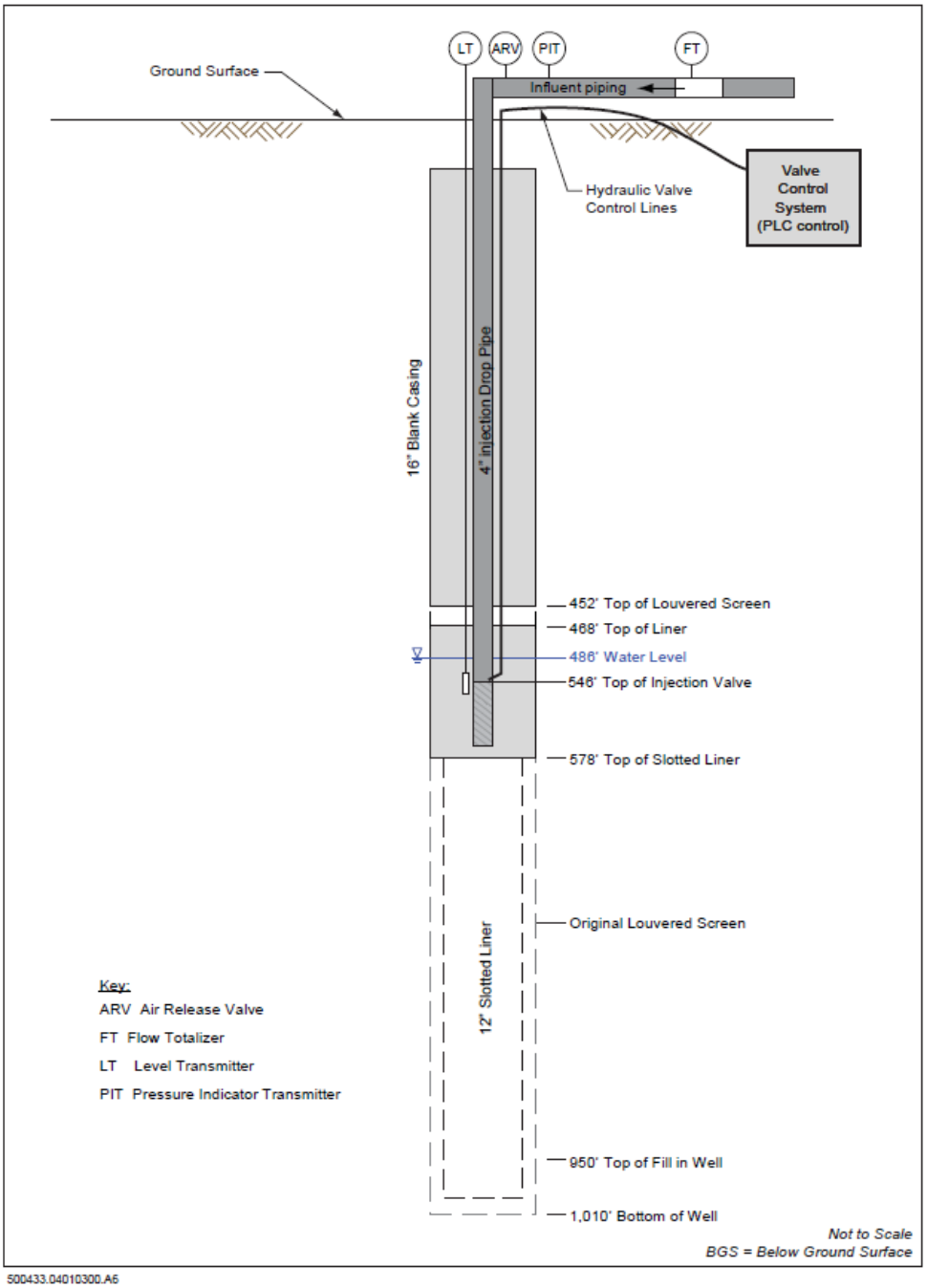
Michelle Hunter, Chief
Ground Water Quality Bureau
New Mexico Environment Department

Appendix A

Injection Well Configuration (KAFB-7)



500433.04010300.A6

Appendix B

Designated UIC Area and Nitrate Plume

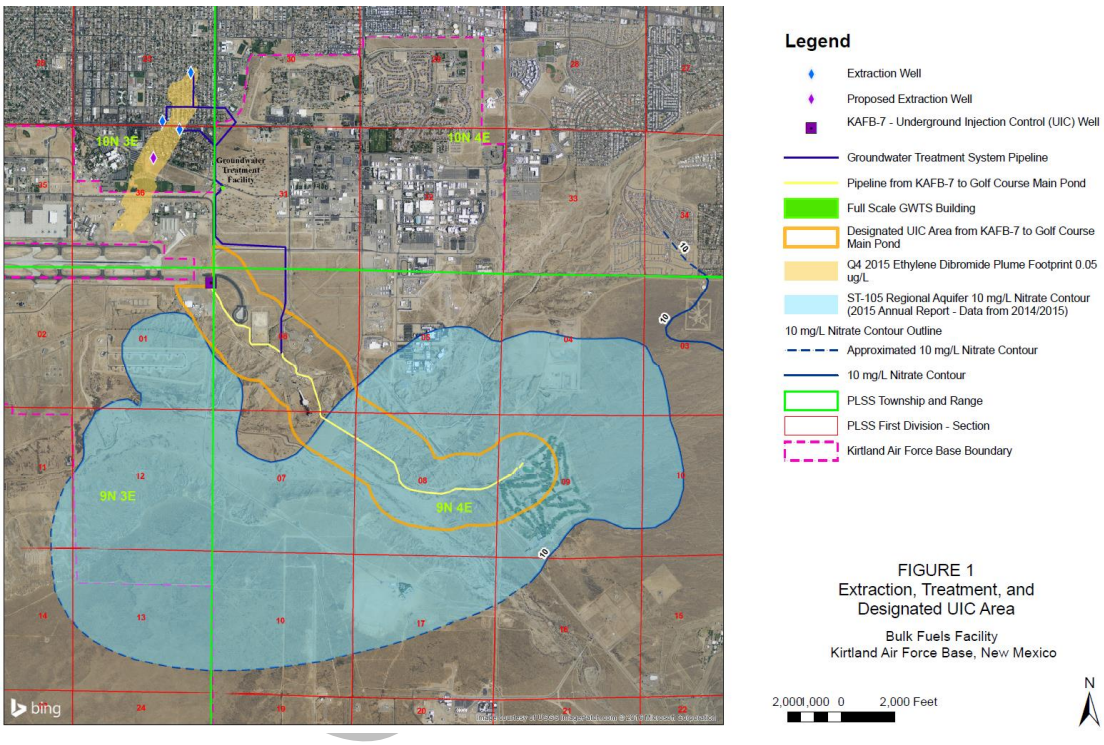


FIGURE 1
Extraction, Treatment, and Designated UIC Area

Bulk Fuels Facility
Kirtland Air Force Base, New Mexico

Appendix C

Contingency Plan

This Contingency Plan (Plan) has been developed for DP-1839 pursuant to 20.6.2.3107(A)(10) NMAC to cope with a failure of the Discharge Permit or system. This Plan describes the actions that Kirtland Air Force Base (AFB) will take in the event of a failure of Discharge Permit 1839 (DP-1839) or the systems that generates and discharges the treated effluent that is the subject of DP-1839. The provisions of this Plan will be carried out immediately whenever there is a release which could threaten human health or the environment.

1.0 BACKGROUND

The groundwater treatment system (GWTS) treats groundwater that contains low concentrations of fuel-related organic compounds, primarily ethylene dibromide (EDB), from a historic leak of aviation gasoline and jet fuel in groundwater which is conveyed to the GWTS from the extraction well network off-base. The GWTS and the associated infrastructure are part of an interim measure pump and treat system that is being implemented under the corrective action provisions in Part 6.2.2.2.12 of Kirtland AFB's Hazardous Waste Treatment Facility Operating Permit (HWTF Permit No. NM9570024423 –"RCRA Permit"). The RCRA permit is enforced by the New Mexico Environment Department's (NMED's) Hazardous Waste Bureau (HWB). DP-1839 regulates the discharge of treated effluent from the GWTS to one or more underground injection control (UIC) wells.

2.0 GWTS OVERVIEW

Contaminated groundwater is pumped from extraction wells and distributed through a piping system to the GWTS. Contaminated groundwater may also originate from groundwater monitoring or extraction wells associated with the BFF corrective action that are undergoing development, testing, or sampling. The granular active carbon (GAC) vessels are arranged in series to provide the contact time required for the removal of EDB and other fuel related organic compounds to achieve the effluent standards in Condition #6. Sampling is conducted at the influent to the GWTS, between the lead-lag GAC tanks, and at the effluent port prior to discharge to the UIC well(s) in accordance with the frequencies established in the most current version of the "*Operations and Maintenance Plan Groundwater Treatment System Bulk Fuels Facility Solid Waste Management Unit ST-106/SS-111*" that has been approved by the NMED HWB.

To ensure that the treated effluent meets all applicable effluent standards in DP-1839, Kirtland AFB has conservatively defined breakthrough as contaminant removal of equal to 90% of the applicable effluent standard as measured between the GAC vessels. If contaminant breakthrough occurs in the lead GAC vessel, the vessels are switched in the lead-lag position and GAC change-out is scheduled. Sampling frequency is increased for any GWTS system change (i.e., new extraction wells added to system).

Samples are collected from the GTWS effluent pipe on a monthly basis. Sampling frequency is increased for any GWTS system change (i.e., new extraction wells added to system). In the unlikely event that the GWTS cannot achieve all applicable effluent standards, the affected treatment train will be shut-down until system modifications can be approved and implemented.

The GWTS is designed and instrumented to efficiently operate 24-hours per day with minimal operator attention. A control system and operator interface panel is installed to allow remote control of the GWTS

and the extraction and injection well network. The control system includes telemetry and web access to alert operators of off-hour alarm conditions. Subcontractor staff are scheduled for on-call responses on weekends and after hours for any emergency response if alarm conditions warrant.

3.0 CONTINGENCY PLAN OVERVIEW

In the event of a spill, leak or unplanned release to the environment associated with the treated effluent from the GWTS or the treated effluent conveyance system, Kirtland AFB will assess possible hazards to human health and/or the environment and will implement this Plan. Possible failures of DP-1839 or the treatment system include the following:

- Treated effluent exceeds one of more of the effluent standards in Condition # 6.
- A leak from the treated effluent conveyance system.
- UIC well is not constructed in a manner consistent with its intended use or completed in a manner that is protective of groundwater.
- The automated monitoring system records a system alarm that indicates a possible threat to a UIC well.

The Permittee's planned response to each of these possible contingencies is described below.

3.1 Treated effluent exceeds one or more effluent standards

As discussed above, the GWTS is operated very conservatively to ensure that effluent standards are never exceeded between the two lead-lag GAC vessels. This is done to ensure that there will be no effluent standard exceedances at the effluent discharge point. In the unlikely event that treated effluent that exceeds one or more effluent standards is discharged to a permitted UIC well, the Permittee will submit a "Notification of Discharge-Removal" to the NMED Groundwater Quality Bureau (GWQB) pursuant to 20.6.2.1203(A) NMAC as required in Condition # 27. The Permittee will copy the NMED HWB on the initial and all subsequent release reports.

In the event of such an exceedance, one or both treatment trains at the GWTS will be promptly shut-down as necessary until system modifications can be approved by the NMED HWB and implemented. If the exceedance is related to concentrations of one or more contaminants in the influent, the Permittees will submit a work plan to the NMED HWB to sample one or more extraction wells. If necessary, an extraction well with an exceedance will be taken off line until the problem is addressed and the NMED HWB authorizes the well to begin pumping again. If plant adjustments are necessary, the Permittee will make the necessary changes. If the required corrective actions are considered to be outside the scope of work for plant operations, one or both treatment trains at the GWTS will be shut down and Kirtland AFB will submit a corrective action plan to the NMED HWB and copy the GWQB. One or both treatment trains at the GWTS will remain shut down pending the approval of the corrective action plan from the NMED HWB.

Following the necessary changes, the effluent groundwater will be re-tested, and the GWTS monitoring frequency will be increased as required in Discharge Permit (i.e., daily for the first week and weekly for three additional weeks). After 4 consecutive weeks of analytical results below the applicable effluent standards, monitoring will return to a monthly frequency.

If necessary, Kirtland AFB will sample groundwater associated with the affected UIC well(s) for all relevant constituents and will provide the data to the NMED HWB and GWQB. Any groundwater

corrective actions will be implemented pursuant to Part 6.2.2 of the RCRA Permit. The Permittee will copy the NMED GWQB on all documents related to the corrective action required in Condition # 26.

3.2 Leak from treated effluent conveyance system

As discussed above, the treated effluent meets all applicable effluent standards in Condition #6. In the event there is a leak from the treated effluent conveyance system that transports the treated effluent to a UIC well, the Permittee will conservatively submit a "Notification of Discharge-Removal" to the NMED GWQB pursuant to 20.6.2.1203(A) NMAC, which includes an estimate of the volumes released, the location of the release and the likely cause of the failure. The Permittee will copy the NMED HWB on the initial and all subsequent release reports.

If necessary, corrective actions will be implemented pursuant to Part 6.2.2 of the RCRA Permit. The Permittee will copy the NMED GWQB on all documents related to the corrective action as required in Condition # 27.

3.3 UIC well is not constructed in a manner consistent with its intended use or not completed in a manner that is protective of groundwater

The design of any new UIC well installed under DP-1839 is subject to approval in accordance with Condition #10. In the unlikely event that a well is not constructed or completed to meet the approved specifications and a design change has not been approved by NMED, the Permittee will submit a work plan to NMED with a proposal for well rehabilitation, abandonment only or abandonment and replacement as detailed in Condition #28.

3.4 The automated monitoring system records a system alarm that indicates a possible threat to a UIC well

Alarms may be activated in the UIC well either due to pressure reading in the discharge pipe or a fluid level in the well casing outside of the operating parameters. Both alarms automatically shut-down the GWTS. Operators will be notified immediately by email of the alarm condition, and proceed to investigate the alarms through the human machine interface (HMI) at the site or remote access after-hours to determine if the alarm represents actual field conditions. Corrective action and subsequent reporting will depend on the condition causing the alarm condition.

4.0 RELEASE NOTIFICATION REQUIREMENTS

4.1 External Notification Procedures

In the event of a spill, leak or unplanned release to the environment associated with the treated effluent from the GWTS or the treated effluent conveyance system, Kirtland AFB will follow the release reporting requirements in 20.6.2.1203(A) NMAC. These requirements are fundamentally equivalent to the "Twenty-Four Hour and Subsequent Reporting" requirements in Part 1.27 of the RCRA Permit. The NMED HWB will be copied on all notifications and any subsequent reports.

4.2 Internal Notification Procedures

GWTS Operators/Contractor staff notify the Chief of Environmental Restoration Program at Kirtland AFB by telephone and by email immediately following any accidental releases of untreated/treated water

at the GWTS, immediately upon having knowledge of a non-compliance event (i.e., sampling results), or if the GWTS operation has to be shut down continuously for more than 24 hours (may include normal maintenance, equipment repairs, or alarm investigations).